SEMICONDUCTOR PACKAGE FOR ENHANCING HEAT DISSIPATION

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates to a heat-dissipation-enhanced semiconductor package, and particularly to a heat-dissipation-enhanced semiconductor package which could be applied in a thin product for reducing the probability of product's delamination and the steps of manufacturing process.

2. Description of the related art

For the technology of semiconductor package, how to efficiently resolve the problem of heat dissipation is a very important issue. A semiconductor package with bad heat dissipation could not only create a series of errors, but also reduce the product reliability and increase much manufacturing cost.

FIG. 1 shows a prior art DHS (Drop-in Heat Sink) structure of a semiconductor package disclosed in U.S. Patent No. 5,225,710. The package structure comprises: a die pad 14; a die 12, which is mounted to a first surface 141 of the die pad 14 with a die attach adhesive 15, such as a silver paste; a plurality of leads 13, which are electrically connected to an active surface 121 of the die 12 with a plurality of bonding wires 17, such as gold wires; the die pad 14 and the plurality of leads 13 are all a part of a leadframe; a heat sink 16, which is located inside the lower mold 19 and contacts the bottom of the lower mold 19 with contacts 161 and 162, and another surface of the heat sink is attached to the second surface 142 of the die pad 14; and an encapsulant 11, which is injected to fill the molding cavity of the package structure when the upper mold 18 and lower mold 19 are closed. The characteristic of the prior art package structure is that the

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heat generated ~~by the~~ die 12 could be dissipated from the die pad 14, through the heat sink 16 ~~attached~~ to the die pad 14 and then to the atmosphere.

FIG. 2 is a prior art EDHS (Exposed Drop-in Heat Sink) structure of a semiconductor package disclosed in U.S. Patent No. 5,381,042. The difference of the EDHS structure from the DHS structure is that a heat sink 21 with a flat bottom in the EDHS structure is directly exposed to the bottom of the semiconductor package unlike the heat sink 16 of the DHS structure contacting the bottom of the semiconductor package through the contacts 161 and 162. The exposed drop-in heat sink 21 has a larger contact area than the drop-in heat sink 16 to dissipate the heat. Therefore, the effect of heat dissipation in the EDHS structure is better than that in the DHS structure.

But both the DHS and EDHS structure have the following disadvantages:

1. During manufacturing processes, the heat sink should be put inside the lower mold 19 first, and the die pad 14 is then aligned to the heat sink. In other words, an extra process step is added, the cycle time of the manufacturing process is increased, and thus the throughput is reduced.

2. The drop-in heat sink 16 or the exposed drop-in heat sink 21 is covered by the encapsulant 11, but both the heat sinks and the encapsulant have different CTE (Coefficient of Thermal Expansion). When the structure suffers from expansion and shrinking, the effect of thermal stress will be created on the contact surface between the heat sink and the encapsulant, and delamination will be created on the contact surface. Besides, the amounts of the encapsulant 11 inside the upper mold 18 and lower mold 19 are not the same, and the package structure will be warped due to different shrinking strengthes after being cooled. The moisture in the atmosphere will permeate into cracks caused by delamination or warping, and the reliability of the semiconductor package will be reduced.

3. Besides, when the encapsulate 11 is injected, the heat sink 21 is fixed by four tie bars on the diagonals of the leadframe (not shown). As the strength of the four tie bars are not necessarily large enough to fix the heat sink 21, some flashed encapsulant will be left on the bottom of the semiconductor package after encapsulation. The manufacturing cost will be increased because a deflashing action should be taken.

4. In the above two prior arts, the heat dissipation paths start from the die 12, through the die pad 14, then through the heat sinks 16 or 21, and to the atmosphere at last. Because the heat dissipation paths are limited; for example, the plurality of leads cannot be used for dissipating the heat, the efficiency of the heat dissipation will be reduced.

5. For some thin products, such as some consumer IC whose thickness P is less than 1.00mm (in other words, the thickness of the lower mold is less than 0.45mm), the heat sink 16 or 21 cannot be put inside the package due to small thickness.

SUMMARY OF THE INVENTION

The first object of the present invention is to propose a semiconductor package which has no need to put a heat sink inside the lower mold before it is encapsulated.

The second object of the present invention is to propose a semiconductor package which will not cause delamination due to different CTE between the encapsulant and the heat sink.

The third object of the present invention is to propose a semiconductor package which has no need to process a deflashing process.

The fourth object of the present invention is to propose a semiconductor package which could use a plurality of leads for dissipating the heat generated by the die.

The fifth object of the present invention is to propose a semiconductor package which could be applied in a thin product, such as TQFP (Thin Quad Flat Package) or TSOP (Thin Small Outline Package).

For achieving the above purposes, the present invention discloses a semiconductor package for enhancing heat dissipation. Only the upper mold is encapsulated, and a heat sink having a thickness variable with demands is mounted to the die pad and a part of the plurality of leads with a thermally conductive and electrically insulating adhesive glue. As the thickness of the heat sink is adjustable according to user's demands, and is not limited by the thickness specification of the lower mold in prior art, the present invention is more suitable for manufacturing thin products. The width of the heat sink covers the die pad and a part of the plurality of leads, therefore the heat generated by the die could be not only dissipated to the atmosphere through the heat sink and leadframe, but also dissipated through the heat sink and the printed circuit board mounted to the leads of the leadframe by conduction. In manufacturing process of the semiconductor package for enhancing heat dissipation, there is no need to be aligned accurately between the die pad and the heat sink, and is also no need to pressure the heat sink by the tie bars of the leadframe, therefore the cycle time of manufacturing process would be reduced, and the throughput would be raised. Besides, the heat sink according to the present invention is not encapsulated inside the lower mold, but mounted to the die pad and a part of the plurality of leads with an adhesive glue, therefore even the CTEs of the heat sink and encapsulant or the leadframe are not the same, the encapsulant will not be cracked or delaminated when the structure suffers from expansion and shrinking, and the reliability of the semiconductor package will be raised. Finally, even the flash is created when encapsulating the upper mold, and the bad appearance will be hidden after mounting the heat sink to the die pad and a part of the plurality of leads. In other words, the present invention would avoid the deflashing step in prior art.

The first embodiment of the semiconductor package for enhancing heat dissipation according to the present invention mainly comprises a die, a leadframe, an encapsulant and a heat sink. The leadframe includes a die pad having a first surface which the die is mounted to and a plurality of leads electrically connected to an active surface of said die through a plurality of bonding wires. The encapsulant is used to seal said die and leadframe. The heat sink is mounted to the second surface of the die pad and the plurality of leads with a thermally conductive and electrically insulating adhesive glue.

The second embodiment of the semiconductor package for enhancing heat dissipation according to the present invention mainly comprises a die, a leadframe, an encapsulant and a heat sink. The die includes an active surface and a second surface. The leadframe includes a central-hole die pad and a plurality of leads, wherein the central-hole die pad has a first surface which the die is mounted to and a second surface. The plurality of leads are electrically connected to the active surface of the die through a plurality of bonding wires. The encapsulant is used to seal the die and leadframe. The heat sink is a T-type structure, mounted to the second surface of the die, the second surface of the die pad and the plurality of leads with a thermally conductive and electrically insulating adhesive glue.

The third embodiment of the semiconductor package for enhancing heat dissipation according to the present invention mainly comprises a die, a leadframe, an encapsulant and a heat sink. The die includes an active surface. The leadframe includes a plurality of leads for mounting the die and a plurality of leads electrically connected to an active surface of the die through a plurality of bonding wires. The encapsulant is used to seal the die and leadframe. The heat sink is mounted to the plurality of leads with a thermally conductive and electrically insulating adhesive glue.

The manufacturing method of the first embodiment of the semiconductor package for enhancing heat dissipation according to the

present invention mainly comprises steps (a) to (d). In step (a), the die is mounted to the first surface of the die pad, and the plurality of bonding wires are used to electrically connect the active surface of the die and the plurality of leads. In step (b), an upper mold for sealing the die and leadframe is encapsulated. In step (c), the heat sink is mounted to the second surface of the die pad and a part of the plurality of leads with the thermally conductive and electrically insulating adhesive glue. In step (d), the leadframe is formed and singulated.

The manufacturing method of the second embodiment of the semiconductor package for enhancing heat dissipation according to the present invention mainly comprises steps (a) to (d). In step (a), the die is mounted to the first surface of the die pad, and the plurality of bonding wires are used to electrically connect the active surface of the die and the plurality of leads. In step (b), an upper mold for sealing the die and leadframe is encapsulated. In step (c), the heat sink is mounted to the second surface of the die, the second surface of the die pad and a part of the plurality of leads with the thermally conductive and electrically insulating adhesive glue. In step (d), the leadframe is formed and singulated.

The manufacturing method of the third embodiment of the semiconductor package for enhancing heat dissipation according to the present invention mainly comprises steps (a) to (d). In step (a), a die is mounted to the plurality of leads, and the plurality of bonding wires are used to electrically connect the active surface of the die and the plurality of leads. In step (b), only the upper mold for sealing said die and leadframe is encapsulated. In step (c), the heat sink is mounted to a part of the plurality of leads with the thermally conductive and electrically insulating adhesive glue. In step (d), the leadframe is formed and singulated.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described according to the appended drawings in which:

FIG. 1 is a prior art DHS structure of a semiconductor package;

FIG. 2 is a prior art EDHS structure of a semiconductor package;

FIGs. 3(a) to 3(d) show semi-products manufactured by a manufacturing process of the present invention;

FIG. 4 shows an embodiment of a cavity-down package structure according to the present invention;

FIG. 5 shows an embodiment of a package structure according to the present invention; and

FIG. 6 shows another embodiment of a package structure according to the present invention.

PREFERRED EMBODIMENT OF THE PRESENT INVENTION

FIGs. 3(a) to 3(d) show semi-products manufactured by the manufacturing process of the present invention. As shown in FIG. 3(a), a die 12 is mounted to a first surface 141 of the die pad 14 first, and the wiring bonding is processed between the active surface 121 of the die 12 and a plurality of leads 13. Afterwards, only the upper mold 18 is encapsulated.

As shown in FIG. 3(b), after the encapsulation of the upper mold 18, a heat sink 31 is mounted to the second surface 142 of the die pad 14 and a part of the plurality of leads 13 with adhesive glue 32. The thickness of the heat sink 31 could be suitably chosen according to the specification of the thin product. Therefore the limitation in prior art that the thickness of the heat sink should be less than that of the lower mold can be avoided in the present invention. The adhesive glue 32 should be a thermally conductive but not electrically conductive one, such as well-known epoxy, B-stage epoxy or silicone, and the present invention does not limit the kind of the materials. If a well-known B-stage epoxy, which is half-dry at about 50℃,

is used as adhesive glue, the heat sink 31 will be firmly mounted to the die pad 14, the encapsulant 11 and a part of the plurality of leads 13 due to high pressures and high temperatures. The material of the heat sink 31 could be made of well-known copper, copper alloy, aluminum or aluminum alloy, and the present invention does not limit the kind of the materials.

As shown in FIG. 3(c), after the heat sink 31 mounted to the upper mold 18, a forming step is executed to bend the plurality of leads 13 towards the heat sink 31, and a singulating step is executed to cut off the four tie bars (not shown) of the leadframe.

The structure in FIG. 3(c) is to bend the plurality of leads towards the heat sink 31 in the forming step to form a so-called "cavity-up type" package. Another structure in FIG. 3(d) is to warp the plurality of leads towards the direction of the upper mold 18 in forming step to form a so-called "cavity-down type" package.

FIG. 4 shows an embodiment of a cavity-down package structure according to the present invention. In the structure of FIG. 4, the top of the heat sink 31 is further added a heat radiator 41 for dissipating the heat generated by the die 12 to the atmosphere by convection and radiation.

FIG. 5 shows an embodiment of a package structure according to the present invention. The difference between the embodiment in FIG. 4 and that in FIG. 5 is that the die pad 14 is a central-hole type, means that the die pad 14 could be split into two parts and left a central hole. The advantage of the design is to reduce the probability of delamination between the die 12 and the die pad 14. The heat sink 31 could be a T-shaped structure. After the encapsulation of the upper mold 18, the heat sink 31 is mounted to the second surface 122 of the die 12, the die pad 14 and the leads 13, and the manufacturing process is finished by the forming step and singulating step.

FIG. 6 shows another embodiment of a package structure according to the present invention. The difference from the above two embodiments

is that the package structure does not have a die pad, the die 12 is adhered to the leads 13 with die attach adhesive 15. The design is suitable to a leadframe mounted to the die of any sizes. As shown in FIGs. 3(b) and 3(c), after the encapsulation of the upper mold, the heat sink 31 is mounted to a part of the plurality of leads by the adhesive glue 32, and the manufacturing process is finished by the forming and singulating steps.

The heat sink 31 according to the invention is not inside the encapsulation. Therefore, even the CTEs of the heat sink 31 and the encapsulation are not the same, and the disadvantage of delamination will not occur due to the use of the adhesive glue as a buffering layer. Besides, cracks due to thermal stress would not be created. Therefore, the reliability of the package according to the present invention could be raised. Furthermore, the encapsulation is performed only in the upper mold. Therefore, there is no need to conduct a deflashing step as in the prior art because there is no flash on the heat sink. Although the bottom of the upper mold 18 would leave behind flash, the problem would be eliminated after the upper mold is mounted to the heat sink 31 with the adhesive glue 32, and the appearance and function of the semiconductor package according to the present invention will not be affected. In addition, as the die 12 and the plurality of leads 13 are mounted to the heat sink 31 with a thermally conductive adhesive glue 32, another heat dissipation path is formed and starts from the die 12, through the die pad 14, the heat sink 31, the plurality of leads 13, and to the printed circuit board (not shown) on which the package is mounted, in addition to the prior art path from the die 12, the die pad 14, the heat sink 31, and to the atmosphere.

The present invention does not limit the kind of the semiconductor packages, but is most suitable to the semiconductor packages of TQFP and TSOP.

The above-described embodiments of the present invention are intended to be illustrated only. Numerous alternative embodiments may be

devised by those skilled in the art without departing from the scope of the following claims.